

## **Protective Clothing Based on Permselective Membrane and Carbon Adsorption**

### **Technology Need:**

Decontamination workers at Department of Energy (DOE) sites face potential contamination from a variety of hazardous compounds, including asbestos; mercury and other heavy metals; toxic organic compounds, such as polychlorinated biphenyls (PCB's) and chlorinated solvents; and radioactive metals and salts. For many activities, they must wear protective garments which are impermeable to particulates, aerosols, and organic vapors and which provide protection from toxic contaminants. Current garments are hot, heavy, time consuming to put on and remove, and impermeable to water vapor. Because body heat cannot escape, the potential for workers to become heat stressed is high, and frequent, lengthy rest periods are needed. Use of existing protective garments greatly reduces worker and process efficiency. Protective clothing that minimizes heat stress while maximizing worker comfort is needed

### **Technology Description:**

Membrane Technology Research, Inc. (MTR), has developed improved protective clothing that provides personnel protection equivalent to current garments, but is water-vapor permeable to minimize heat stress, and lighter weight for improved wearer comfort. The improved protective clothing will be made of an innovative fabric that combines an ultra-thin, permselective outer membrane with a sorptive inner layer. The outer membrane layer is extremely permeable to water, but highly impermeable to hazardous compounds; the sorptive inner layer captures any hazardous compounds that may breach the membrane layer.

The outer fabric that contacts the contaminated atmosphere is a nonporous, but permselective, polymer membrane. It permits the permeation of water vapor,

but is essentially impermeable to toxic organic compounds. Since the membrane is nonporous, it also acts as a complete barrier to penetration by particulates, aerosols, and liquids. Because penetration of the hazardous compound is greatly reduced by the permselective membrane, the sorptive layer can be relatively thin. The sorptive layer consists of zeolite adsorbent dispersed in a microporous support membrane. The membrane layers are supported on a woven fabric that provides mechanical strength. A protective layer covering the outer surface of the permselective layer makes the fabric water repellent, seals any defects, and protects the permselective layer from abrasion.



**Worker Wearing MTR's Permselective Garment**

### **Benefits:**

- Increased worker productivity due to greater comfort and reduced rest time
- Reduced potential for heat stress due to the very-high water vapor transmission rate of the new fabric (up to 600-900 g/m<sup>2</sup>-day)

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►Improved worker acceptance of protective clothing due to increased comfort

►Equivalent, or better, protection of personnel by the new fabric

## Status and Accomplishments:

The permselective membrane material development project concluded in September 2001. The draft final report indicates that the Membrane Technology and Research (MTR), Inc., developed permselective membrane fabrics provide liquid splash protection while allowing for perspiration release through the garment. During Phase II, the permselective fabric manufacturing steps were significantly simplified, resulting in a 30 percent reduction in manufacturing costs. Permselective membrane protective suits were prepared in collaboration with a potential garment manufacturer and heat stress testing with human test subjects was conducted by the International Union of Operating Engineers (IUOE). The IUOE tests confirmed that the MTR protective fabric is significantly more comfortable than non-breathable materials. The life cycle costs for the MTR permselective protective fabric compared very favorably with polyvinyl chloride and Saranex/Tyvek coveralls. These costs are dependent upon garment cost, reuse, decontamination, maintenance, storage, and disposal. Using the MTR suit twice before disposal results in a total-cost-per-productive-hour of \$25.90, which is a very significant saving over the Phase I economic analysis and similar splash protective garments. Along with the detailed economic analysis that was performed, market opportunities were identified for the novel MTR protective fabric: (1) liquid splash protective clothing for hazardous waste site operations; (2) liquid splash protective clothing for emergency response, and (3) Class 3 NFPA 1994-compliant protective clothing for civilian use during chemical terrorism incidents. At the present time, MTR's collaborative partner is not proceeding with commercialization of the MTR permselective protective fabric.

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## Online Resources:

Office of Science and Technology, Technology Management System (TMS), Tech ID # 95  
<http://ost.em.doe.gov/tms>

The National Energy Technology Laboratory Internet address is <http://www.netl.doe.gov>

For additional information on this technology, please visit Membrane Technology Research, Inc.'s website at <http://www.mtrinc.com/index.html>